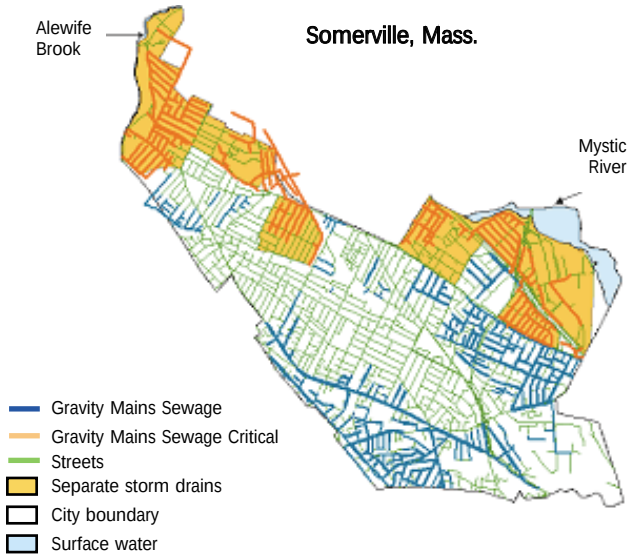
A GIS Approach to Stormwater Management in Somerville, Mass.

by Vithal V. Deshpande, Environmental Coordinator, City of Somerville, MA, and Britta Roden, M.A. Economics Candidate, Tufts University



Stormwater management is a growing topic of discussion among municipal officials and private industries. In order to attain National Pollution Discharge Elimination System (NPDES) and stormwater phase II permitting, all responsible parties need to develop Best Management Practices (BMPs) and install stormwater treatment technologies. Although each responsible party can have unique sets of stormwater issues and relevant BMPs, a common set of management practices needs to be defined.

The final rule on Stormwater Phase II by the EPA requires smaller municipalities like Somerville to actively pursue improvements in stormwater management and track their BMPs. For Somerville, this meant more than just filing paperwork. The Stormwater Phase II rule was actually an eye-opener that let us think of new innovative approaches to stormwater management. We developed a new way to think of BMPs that allows us to track our progress using Geographic Information Systems (GIS) and an assets database for stormwater management. This system considers principals of Environmental Management System (EMS)/ISO 14000: inventory, impact, and Improvement analysis of existing, proposed, and potential stormwater utilities as the basis to develop the asset management and to incorporate the same in GIS for tracking purposes.

This article discusses the steps that the City of Somerville is adopting to systematically keep track of existing BMPs. Our innovative cost accounting methodology allows us to determine the net gains or losses of BMP assets as part of our stormwater management. In particular, this article illustrates a unique concept of using satellite imagery to analyze the "Tree Canopy" over the city in reducing the stormwater impacts during storm events. The overall analysis using GIS helps in understanding ways and means to deal with stormwater as an environmental concern and as legal liability.

Background

Somerville is located within the lower Mystic River basin and is surrounded by the Mystic River and Alewife Brook along its western and northern parts. The Mystic River is one of three major rivers that drain into the Boston Harbor. Environmental hazards in the Mystic include chemicals leaching from waste disposal sites, contaminated sediments, excessive inputs of plant nutrients, discharges of sewage containing pathogenic bacteria, and inputs of fuel hydrocarbons, road salt and toxic metals in stormwater runoff.

Somerville is the most densely populated urban area in Massachusetts, with a population density of 18,868.1 people per square mile, [4.1 square miles] (Census2000). Given the relatively small space that is shared by the 77,478 Somerville residents, it is crucial to make pollution prevention a priority.

Somerville's population density combines with a lack of pervious surfaces leading to problems with stormwater runoff. The Stormwater Phase II rule by the EPA allowed us to realize that Somerville can be a strong leader in developing methods to address these problems. In particular, Somerville is already successfully addressing local issues of stormwater runoff by eliminating combined sewer overflows (CSOs) and dry weather overflows, monitoring water quality, creating public awareness of storm water issues, and catch basin maintenance. By August 2002, the City's Engineering Department had successfully eliminated nine out of eleven CSOs and the remaining two overflows are under study. In October of 2001, our Environmental Protection Office was awarded an EPA EMPACT grant for a one-year

program designed to study, assess and finally to educate the public on the issue of water quality as it applies to recreational use of the Mystic River (www.mysticriveronline.org or at www.epa/gov/empact).

Stormwater Assets from the Environmental Management Perspective

Over the years, the City of Somerville adopted an environmentally conscious approach that went beyond the required compliance measures to avert stormwater pollution. However, these stormwater management measures or BMPs were distributed in different departments throughout the City. This departmentalization made it difficult to track the success in terms of environmental and socioeconomic gains. In order to track progress and success we considered a "Continuous Improvement Process" model featured in the ISO14000 Series for Environmental Management Systems (EMS). EMS at its core can be summarized by three actions: Inventory Analysis, Impact Analysis and Improvement Analysis. These actions "Inventory, Impact, Improvement," formed the foundation for this project.

BMP Inventory System

After entering into a cooperative agreement granted to the City by Region 1 of the EPA, Somerville initiated a one-year in-house project to develop a tracking system to manage stormwater assets. As a first step of this project, we developed a detailed inventory of BMPs, including cost information, responsible parties, goals for and current status of each BMP.
A Geographic Information System (GIS) was used to develop layers of structural BMPs such as catch basins, catch basin cleanups, stormwater treatment systems, storm drains, combined sewer overflows, and a street sweeping schedule. For completeness, the inventory database also included non-structural BMPs such as the household hazardous waste collection program, educational materials and outreach, the hazardous chemicals database, pollution prevention and good housekeeping measures, the illicit discharge detection and elimination program and construction site run-off control.

GIS Analysis of Tree Canopy and Benefits to Stormwater Management

In addition to analyzing BMPs as GIS layers, we turned to an alternative approach relating to stormwater management that involved the amount of tree cover within a city. Trees are part of our lives. However, with high population density and increasingly paved backyards for car parking, slowly and steadily urban landscapes are missing green space. This has direct impacts on stormwater runoff and water quality. The idea was that Somerville could reduce the amount of runoff by increasing green space and allowing rainwater to infiltrate into the ground. Using satellite imagery, we used GIS to classify land cover and analyzed the effect of different land cover types. The classified land cover map was analyzed using CityGreen software by American Forests. This analysis is based on the TR-55 algorithm developed by the Natural Resources and Conservation Service at the Department of Agriculture.

The results showed us the amount of stormwater runoff avoided by trees, the reduction in air pollution, and the amount of carbon storage and sequestration. Somerville only has 18% tree cover on average, which is relatively low compared to the recommended 25% tree cover in urban areas. Current tree cover is saving the City $8.7 million in stormwater costs, because water is more likely to infiltrate into the ground than wash pollutants into the Mystic River. The City could greatly reduce the amount of surface runoff by increasing its tree cover, which would also reduce stormwater costs, and improve water quality.

Conclusions

Developing a stormwater asset management system works like a hidden treasure, thus providing us with a "Best Management Practice for our BMPs." The system helps us understand the different perspectives of stormwater management – engineering, policy, economics, and educational – and provides directions for better urban environmental planning while satisfying the various regulatory needs. ■

Mr. Vithal V. Deshpande is the Environmental Coordinator, City of Somerville, for the Somerville Environmental Protection office. For more information, please contact him at (617) 625-6600 ext. 5070 or via e-mail at vdeshpande@ci.somerville.ma.us.

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